REMARKS/ARGUMENTS

This Amendment accompanies a Request for Continued Examination and addresses the issues raised in the Official Action of September 2, 2010, a Final Rejection.

In preparing this response an error in the wording of claim 1 was noted. Specifically, "A method of fabricating an infrared device comprising a cadmium mercury telluride, $Hg_{1-x}Cd_xTe$ where x is $0<x<1$, and a device layer, the method comprising..." in claim 1 should read "A method of fabricating an infrared device comprising a cadmium mercury telluride, $Hg_{1-x}Cd_xTe$ where x is $0<x<1$, ~~and a~~ device layer, the method comprising...". In other words, the method involves forming an HgCdTe device layer, not HgCdTe and a device layer.

Claim 1 has been amended to correct this.

In addition, new claim 38 has been added which is a combination of previous dependent claim 6 and amended claim 1. The significance of this new claim will be apparent from the remarks that follow.

The Invention

The present invention is a method of fabricating an infrared device comprising a cadmium mercury telluride, $Hg_{1-x}Cd_xTe$ where x is $0<x<1$, device layer, the method comprising the steps of:

(a) taking a crystalline silicon substrate,

(b) growing one or more buffer layers chosen from zinc telluride, cadmium telluride and cadmium zinc telluride on said substrate by molecular beam epitaxy to form a buffered silicon substrate, and

(c) growing at least one device layer of cadmium mercury telluride on the buffered silicon substrate by metal-organic vapour phase epitaxy.

The invention requires firstly, that the substrate is silicon; secondly, that the device layer is $Hg_{1-x}Cd_xTe$ where x is $0<x<1$; and thirdly, that the buffered substrate comprises one or more layers chosen from zinc telluride, cadmium telluride and cadmium zinc telluride. Furthermore, and importantly, the buffered silicon substrate is formed by molecular beam epitaxy (MBE) and a device layer of cadmium mercury telluride (CMT) is then grown on the buffered substrate by

metal-organic vapour phase epitaxy (MOVPE). In other words, MBE is used to grow the buffered substrate and MOVPE is used to grow the CMT device layer.

Claim 1 recites a very specific combination of method features, which features are advantageous for producing CMT-based infrared devices. As discussed in the original PCT application (c.f. page 6, lines 16-22) the buffer layers set the correct orientation for MOVPE growth and prevent chemical contamination of the cadmium mercury telluride by species in the substrate. The choice of buffer layer depends on the substrate being used and the inventors have found that, in the particular case of growing a cadmium mercury telluride device layer on silicon by metal-organic vapour phase epitaxy, one or more buffer layers chosen from zinc telluride, cadmium telluride and cadmium zinc telluride is suitable. The other key feature of the invention is the combination of two growth techniques, namely MBE for the buffer layer and MOVPE for the device layer. The inventors have found that mixing those particular two techniques – despite adding to the complexity of the method - can provide a reliable and controllable process that has produced excellent devices (c.f. page 5, lines 7-11).

In a particularly preferred embodiment of the invention (as defined by claim 6) the silicon substrate orientation is (001) mis-aligned between 1° and 10° towards the [111] direction. CMT grown on buffer layers on silicon at the {100} orientation has a tendency to form domains and hillock defects. However, the inventors have found that a mis-orientation from (001) of a few degrees towards [111] can eliminate domains and therefore reduce defects (c.f. page 14, lines 17-21.)

Claim Rejections Under 35 USC §102

The Examiner has rejected claims 1, 6, 8, 10 and 11 under 35 USC § 102(b) as anticipated by or, in the alternative, under 35 USC § 103(a) as obvious over US 6,045,614 (de Lyon et al).

De Lyon et al is concerned with the deposition of a (111)-oriented II-VI alloy film on a vicinal Si(111) substrate, thereby enabling the subsequent epitaxial growth of HgCdTe(111) (c.f. column 8, lines 17-20). The (111) orientation of the substrate and of the alloy film is important because it produces a surface – specifically a **CdZnTe** surface - for growing HgCdTe(111) which is twin-free and of high structural quality (c.f. column 8, lines 6-10). With regard to growth methods, the II-VI alloy film (analogous to the buffer layer of the present invention) is

grown by conventional vapour phase deposition techniques such as MBE or MOVPE (c.f. column 5, line 39 and column 5, lines 60-62), and the subsequently deposited HgCdTe layer (analogous to the device layer of the present invention) is deposited by **MBE or LPE** (LPE = liquid phase epitaxy) (c.f. column 8, lines 19-21).

De Lyon et al neither discloses nor suggests that the HgCdTe device layer is deposited by MOVPE (as required by claim 1 of the present invention). Indeed, the document refers to CdTe(111) and CdZnTe(111) being highly preferred over other crystallographic orientations for the growth of HgCdTe by LPE. It is submitted, therefore, that de Lyon et al teaches that LPE is preferred over other growth techniques and hence, that de Lyon et al teaches away from growth by MOVPE.

In support of the rejection of claim 1, the Examiner states that "step c) growing at least one device layer of cadmium mercury telluride on the buffered silicon substrate by metal-organic vapour phase epitaxy" is disclosed at column 1, lines 15-30; column 5, lines 33-67, column 7, lines 24-37; and claim 19. Applicants reject that assertion for the following reasons:

(i) Column 1, lines 15-30 merely discloses that epitaxial HgCdTe is required in HgCdTe IR detectors and detectors arrays, and goes on to state that HgCdTe can be epitaxially grown on a variety of substrates. The section of text mentions that HgCdTe can be grown on a CdTe buffer layer, but the growth method is not disclosed.

(ii) Column 5, lines 33-67 discusses the deposition of the II-VI alloy film (i.e. the II-VI buffer layer). Applicants agree that the alloy film may be deposited by MBE or MOVPE (see the discussion above), but the disclosure relates to buffer layer deposition rather than device layer deposition. Accordingly, the section of text does not disclose the deposition of a cadmium mercury telluride device layer on a buffered silicon substrate by MOVPE.

(iii) Column 7, lines 24-37 deals with possible II-VI materials for the alloy film. The materials may include HgCdTe, but the disclosure relates to the alloy film (buffer) layer rather than the device layer. Hence, although the buffer layer may comprise HgCdTe, it is nevertheless the buffer layer that may be deposited by MBE or MOVPE in de Lyon et al and not the device layer. Once again, de Lyon et al does

not disclose the deposition of a cadmium mercury telluride device layer on a buffered silicon substrate by MOVPE.

(iv) Claim 19 merely states that a layer of epitaxial HgCdTe(111) is formed on the surface of an optional second layer of the alloy film, and is silent on the growth method.

In view of the above, applicants submit that de Lyon et al neither teaches nor suggests the particular combination of features of claim 1, and certainly neither discloses nor suggests that the HgCdTe device layer is grown by MOVPE. The Examiner has made clear factual errors in rejecting claim 1 over de Lyon et al, and reconsideration of the rejection is respectfully requested.

With regard to claim 6, the Examiner has stated that de Lyon et al discloses, at column 6, lines 1-10, that the silicon orientation is (001) mis-aligned between 1° and 10° towards the [111] direction. Again, this is **INCORRECT**. De Lyon et al is concerned with the growth of (**111**)-oriented - as opposed to (001)-oriented - II-VI alloys, and the section of text referred to by the Examiner quite clearly discloses a vicinal Si(***111***) plane tilted 2° to 8° away from the exact Si(***111***) plane towards the (***211***) plane. Accordingly, claim 6 is patentable by virtue of its dependency on claim 1, and also contains novel and non-obvious subject matter.

Claims 8, 10 and 11 are patentable by virtue of their respective dependencies.

Claim Rejections Under 35 USC §103

Rejections under 35 USC § 103 have been raised in respect of dependent claims 9, 12 and 13-22 only. It is submitted that those claims are patentable by virtue of their respective dependencies.

For the above reasons it is respectfully submitted that all pending claims define novel and inventive subject matter. Should the examiner require further information, please contact the undersigned.

The Commissioner is hereby authorized to charge any deficiency, or credit any overpayment, in the fee(s) filed, or asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 14-1140.

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: /Arthur R. Crawford/
Arthur R. Crawford
Reg. No. 25,327

ARC:caw
901 North Glebe Road, 11th Floor
Arlington, VA 22203-1808
Telephone: (703) 816-4000
Facsimile: (703) 816-4100